Date Sensitive Computing Problems

Understanding the Threat

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"Human history becomes more and more a race between education and catastrophe."
-H. G. Wells

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As the 21st century approaches, widespread failures in computers and computer controlled equipment are predicted. The mechanism for these failures is called the millennium bug, or the year 2000 bug (abbreviated as "y2k bug"). The results of many computer failures over a short period time will cause considerable social and economic disruptions. These failures and disruptions are hereafter referred to as the "y2k technology crisis." There is more to this problem, however, than just technology. The technological failures will cause many non-technical problems as society reacts to the difficulties caused by the y2k bug. The y2k crisis, a combination of the technological and sociological problems, may be increased by superstition surrounding the year 2000 and the new millennium.

THE PROBLEM

The foundation of this problem began in the early 1960's and 1970's. At this dawn of the electronic age, computer memory was extremely expensive. As a cost cutting measure, early computer programmers decided to record dates using only the last two digits for the year; the first two digits, 19, were taken as being understood by the system. These early programmers realized that this method of time calculation in computer programs would cause a problem on January 1, 2000, but it was the general consensus that a different method of time calculation would be used in computer programs well before this date.

They were wrong. This method of time calculation was used in almost every computer program until the late 1990's. Indeed, even today not all computer programs or embedded chips use a time format that contains the year calculation in a four digit format. Thus, no computer program or embedded chip can be taken for granted.

COMPUTER SOFTWARE

Computer programs are used at every level of society for a variety of purposes. Many of these programs will be dramatically affected on January 1, 2000. Computers, security systems, financial transactions, automated manufacturing facilities, even the satellites that control everything from television to pagers, could possibly fail. When these programs register the year turning from 99 to 00, the majority will 'understand' that time has gone from 1999 to 1900. Computer programs that calculate interest due on loans for financial institutions could detect a 99 year failure to pay the payments due or determine that such payments are no longer due for another 99 years. Voter registration programs could disqualify millions of voters due to they fact they have failed to vote for the last 99 years. Millions of Social Security checks could stop as the system registers their recipients as being a "negative" years old in 1900 and thus ineligible for benefits.

It is also possible that many of these programs will simply cease to function. Programs dealing with age, for example, rarely have the capability to deal with an entry for someone who is a negative fifty years old. In many cases, this failure to function would actually be a blessing in

disguise. When these programs fail, it will become obvious to the user that a date failure has occurred. Such failures can be detected and corrected at a fairly quick pace with proper allocation of resources. A greater danger is those programs which remain running but begin supplying faulty data based on incorrect calculations. Unless such data is obvious nonsense, organizations run the risk of catastrophic failures if they rely upon the faulty data.

Attempts to repair faulty computer programs face many hurtles. Some of these programs have been in use for decades, being only slightly modified since their inception. Such programs may be written in harder to correct early computer programming languages such as COBOL or FORTRAN. Other programs may have been specially designed and written for a specific purpose by a single programmer. If that programmer is unavailable, it may prove impossible to salvage the program, forcing the organization to develop a totally new replacement. Even those programs which, standing alone, may not be affected by the 2000 date change could cease to function properly if they receive faulty data from any other programs which are affected. Since many computer systems consist of dozens of separate programs integrated together to accomplish their purpose, it may be difficult or impossible to determine which programs may be affected in such ways. In any case, correction or prevention of such problems remains a daunting task.

DATE SENSITIVE EMBEDDED SYSTEMS

Date sensitive embedded systems consist of computer chips that are built into various pieces of electronic equipment. These chips have small computer programs physically etched into the chip. The chips are in most electronics, from computers to manufacturing plants, from telephone systems to alarm systems. Any electronic devices that require the determination of the passage of time will contain them.

Any chips whose programs were designed to maintain time in a method that records the year using only two digits will be affected when the chip's internal clock reaches January 1, 2000 and the year moves from 99 to 00. These flaws will cause the chips to read the date as 1900 instead of 2000. Depending on the exact purpose of the chip, this failure could cause the equipment controlled by the chips to either stop working or begin producing false or misleading information. For many computer chips, this failure will occur on January 1, 2000. Embedded chips which only measure relative time, however, may never have had their internal clocks set properly and could be off by several years.[1] These chips may fail when their internal clocks reach January 1, 2000 regardless of the calendar date.

It is estimated that there are 20 to 40 billion chips in use in the world today. Approximately 7 billion were shipped in 1997 alone. It has also been estimated that from 0.02 to a maximum of 10 percent of these embedded chips will be affected by the year 2000 date change.

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[1] For more information, see "Embedded Systems and the Year 2000 Problem" available at http://www.tmn.com/~frautsch/y2k2.html

These estimates mean that from 4 million to 4 billion chips must be replaced in order to avoid the consequent problems. Even more daunting, it is impossible to determine from available information exactly which chips must be replaced, requiring the testing of all embedded chips to detect and replace those chips that will be affected by this problem.

IMPORTANT DATES

Due to the nature of the y2k technology crisis, failures will be spread across a number of dates, with the greatest number concentrated around 01/01/2000. Other dates that are also possible critical failure dates:[2]

- - /- - /1999	Some programmers used the 99 year date to designate an end-file signal default code. Such programs will fail when the date designation moves from 98 to 99.
02/05/1999	Most airlines take reservations up to 330 days in advance. On this date, year 2000 reservations will be entered for the first time into airline computers. It is possible that this could cause the failure of airline reservation systems.
03/01/1999	Beginning of New York state fiscal year 2000.
07/01/1999	Beginning of fiscal year 2000 for 46 U.S. states.
08/22/1999	End of Global Positioning System (G.P.S.) week 1023. The Global Positioning System was designed to count time by weeks, with a maximum count of 1023 weeks. Thereafter, the system will rollover to week 1, causing some systems which take the date from the G.P.S. to either reset the date as 01/06/1980 or fail entirely.
09/09/1999	Another signal date (9/9/99). See entry for 1999.
10/01/1999	US Federal Government fiscal year 2000 begins.
12/31/1999	This date was used by some programmers as a "never expire" date
- -/- - /2000	Failure of programs and embedded chips as date changes from 99 to 00.
01/07/2000	End of the first working week of 2000. First incident of weekly batch work.
01/31/2000	End of the first calendar month of 2000. First incident of monthly batch work.
01/01/2006	US Federal Aviation Administration computers fail.

ADDITIONAL FACTORS

The sun's 11 year sunspot cycle will reach its next peak during the year 2000. The increased sunspot activity can damage satellites and sensitive equipment on Earth.[3] It can also interfere with electromagnetic signals from such devices as cell phones, radio, televison, and radar. By itself, the increased sunspot activity would not present a serious threat. By occurring

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[2] For more information, see "Critical Dates" available at http://www.merlyn.demon.co.uk/critdate.htm

[3] For more information, see "FAS Millennia Monitor" available at http://www.fas.org/2000/cycle_23.htm

simultaneously with the y2k bug, however, the sunspots will add to the complexity of diagnosing equipment failures during y2k. This synergistic effect will increase the amount of effort needed to correct problems resulting from the y2k technology crisis.

Another astronomical event that could increase the problems of the y2k technology crisis is the unusually strong Leonid meteor storm projected for November of 1999.[4] This very dense and very energetic meteor storm may damage or destroy Earth orbiting satellites and spacecraft. Debris from impacted satellites will add to the existing orbital debris problem, and could eventually cause damage to other satellites. Unlike the situations portrayed in recent films, this meteor shower should present no threat to terrestrial assets.

The most unpredictable aspect of the y2k crisis is how people, individually and in groups, will respond to the y2k technology crisis. Unfortunately, there is a great deal of superstition in many cultural groups regarding the year 2000 and the new millennium. At the turn of the first millennium there was a sharp increase in irrational and superstitious behavior, generally referred to as millennium fever; it is very likely that similar behaviors will be exhibited during the second.[5] The y2k crisis will likely increase the occurrences of millennium fever. The response by society to the y2k crisis will be paramount in determining how the crisis is resolved. Millennium fever adds a great deal of uncertainty to this important consideration and may impair our ability to deal with the technological failures resulting from the y2k bug.

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[4] For more information, see "Leonid Meteors" available at http://sn-callisto.jsc.nasa.gov/newsletter/v2i1/v2i1-2.html#leonid

[5] See "Apocalypse and Millennium Fever Links" available at http://www.sci.fi/~phinnweb/neuro/apocalypse_links.html for some examples of emerging millennium fever.